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(54) Title: CIGARETTE FILTERS AND THE LIKE

(57) Abstract

A filter for tobacco smoke comprises a free-radical inhibitor, particularly an *O*-alkylated derivative of 2,4-monofufurylidene sorbitol, together with an antioxidant to reduce the content of polycyclic aromatic hydrocarbons in the smoke.

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CIGARETTE FILTERS AND THE LIKE

The present invention is concerned with the treatment of filters for tobacco smoke, particularly cigarette filters, to limit the carcinogenic effect of the smoke passed by them to the consumer.

Tobacco smoke, particularly that from cigarettes, is well-known to contain various components which are either carcinogens or pro-carcinogens. One particular class of compounds falling within this category comprises the polycyclic aromatic hydrocarbons (PAH) which are converted by the cytochrome P450 enzyme system in the liver or the lung into oxygenated derivatives which have been shown to be carcinogenic. A considerable amount of literature now exists in this field, for example: Pryor, *et al*. *Science* 220:425-427; Pryor, *et al*. Cancer and Free-Radicals, in Antimutagenesis and Anticarcinogenesis Mechanisms; Ed. D Shankel, *et al*; Plenum Press, New York NY, pages 45-59; Janoff, *et al*. 1987 *Am. Rev. Respir. Dis*. 136:1058-1064 and many others. The effect of free-radicals in the smoke has been extensively discussed, for example by Church and Pryor *Environ. Health. Perspect*. 64:111-126 (1985).

GB-A-1044434 discloses the use of 2,4-monofurfurylidene sorbitol in cigarette filters to reduce the content of PAH in the smoke.

In situations where free-radicals are known to cause harm, for example in the skin, the use of free-radical inhibitors is well-known. For example, EP-B-0 345 362 discloses the use of a particular type of free-radical inhibitor in skin cosmetics. The inhibitor in question is chosen from a group of furfurylidene derivatives of sorbitol, in particular 2,4-monofurfurylidene sorbitol and the tetra-*O*-alkyl derivatives thereof. A method for preparing 2,4-monofurfurylidene sorbitol was disclosed in US-A-3,383,279 comprising gradual addition of furfurol to acidified sorbitol, thus forming the 2,4-*O*-furfurylidene derivative.

We have now investigated the effect of these sorbitol derivatives in other areas. Surprisingly, we have now found that the furfurylidene sorbitol derivatives of EP-B-0 345 362, in combinations with certain other components, can be used to impregnate tobacco smoke filters to achieve smoke which has a dramatically reduced content of PAH. The mechanism of this action is unknown and unexpected: on the model of previous uses of free-

radical inhibitors, it would be expected that the inhibitor must be present at the site of absorption by the body and not at a remote location. The compounds appear to remove mutagenic or carcinogenic compounds from the smoke, but other explanations are possible.

According to the present invention there is thus provided a filter for tobacco smoke comprising means forming a passageway for smoke, characterised in that on a surface of the passageway arranged to contact the smoke there is provided an *O*-alkylated derivative of 2,4-monofurfurylidene sorbitol together with an antioxidant. The *O*-alkylated derivative is desirably a C_{1-5}-alkyl derivative, *e.g.* the methyl derivative, and the tetra-*O*-alkyl derivative is preferred.

The filter according to the invention is particularly represented by a cigarette filter, which may have any conventional construction arranged to provide a very large surface area in contact with the smoke passing through, for example packed filaments, open-cell foams, *etc.*

The free-radical inhibitor may be incorporated in the filter at any effective level, but typically at 2.5-30 mg per filter, especially about 5-20 mg, particularly when tetra-*O*-methyl 2,4-monofurfurylidene sorbitol is used.

The filter also contains an antioxidant and the ratio by weight of the sorbitol derivative to the antioxidant is desirably from about 1.5:1 to 3:1, especially, about 2:1. Particularly preferred antioxidants comprise phenolic antioxidants such as *tert*-butyl-hydroxyanisole (BHA) or *tert*-butyl-hydroxytoluene (BHT).

It appears that there is synergy between the sorbitol derivative and the antioxidant, and both components are necessary for maximum activity.

The active components can be added to the cigarette filter by any convenient method, for example by dosing with a solution of the components and allowing the solvent to evaporate. Alternatively, the packing material for the filter can be pre-impregnated with the active component before the filter is constructed.

The following Example illustrates the invention further.

EXAMPLE - Measurement of benzo[α]pyrene and tar levels

In a series of tests, standard cigarettes were used - either Kentucky Reference 1R3F or commercial cigarettes containing no additives in the filter. The following additives were investigated:

2,4-monofurfurylidene sorbitol tetra-*O*-methyl ether (FT)
tert-butyl-hydroxyanisole (BHA)

The results are summarised in the following table. The stated additive, dissolved in 40-60 μl diethyl ether, was added in six to ten aliquots using a microsyringe to inject through the end of the filter. Control cigarettes were prepared using diethyl ether only. The cigarettes were stored in conditions of controlled humidity and temperature for twenty-four hours and were tested to check that there had been no change in the pressure drop across the filter.

The test methods were standard in the industry for the investigation of cigarette smoking and analysis of tobacco smoke. The cigarettes were "smoked" in a smoking machine conforming to the standard US Federal Trade Commission smoking protocol and the smoke was passed through a Cambridge filter, which was weighed before and after the smoking. The increase in weight of the filter is the total particulate matter (TPM). Nicotine was extracted from the filter by washing with alkaline methanol and estimated using gas chromatography using a nitrogen-phosphorus detection. The water content of the TPM was measured by extracting the filter with ethanol followed by gas chromatography with conductivity detection. Tar is calculated by deducting the nicotine and water contents from the TPM.

Benzo[α]pyrene (BaP) is taken as a representative carcinogen for tobacco smoke and was measured by HPLC analysis (with fluorescence detection) of a cyclohexane extract of the Cambridge filter.

TABLE

FT (mg/cig)		0	20/30	0	0	20
BHA (mg/cig)		0	0	10	30	10
TPM (mg/cig)	Control	19.8				
	FT (20/30 mg)		19.1			
	BHA (10 mg)			19.6		
	BHA (30 mg)				18.7	
	FT (20 mg) + BHA (10 mg)					15.9
Tar (mg/cig)	Control	15.1				
	FT (20/30 mg)		14.4			
	BHA (10 mg)			16.0		
	BHA (30 mg)				14.9	
	FT (20 mg) + BHA (10 mg)					14.0
Nicotine (mg/cig)	Control	1.31				
	FT (20/30 mg)		1.34			
	BHA (10 mg)			1.24		
	BHA (30 mg)				1.25	
	FT (20 mg) + BHA (10 mg)					1.06
BaP (ng/cig)	Control	14.3				
	FT (20/30 mg)		13.0			
	BHA (10 mg)			13.7		
	BHA (30 mg)				7.9	
	FT (20 mg) + BHA (10 mg)					6.6
BaP ≈ Control	Control	100				
	FT (20/30 mg)		91			
	BHA (10 mg)			96		
	BHA (30 mg)				55	
	FT (20 mg) + BHA (10 mg)					46

As can be seen from the last column, for a 2:1 combination of FT and BHA, a highly significant reduction in BaP was noted.

Similar applications in other smoke filters can be envisaged, for example filter cartridges in tobacco pipes. An expert in the art will be

able to foresee several modifications and variations, which will be considered all included within the scope of the present specification.

CLAIMS

1. A filter for tobacco smoke comprising means forming a passageway for smoke, characterised in that on a surface of the passageway arranged to contact the smoke there is provided an *O*-alkylated derivative of 2,4-monofurfurylidene sorbitol together with an antioxidant.

2. A filter according to Claim 1, in which the antioxidant is a phenolic antioxidant.

3. A filter according to Claim 2, in which the antioxidant comprises *tert*-butyl-hydroxyanisole (BHA) or *tert*-butyl-hydroxytoluene (BHT).

4. A filter according to any of Claims 1 to 3, in which the *O*-alkylated derivative comprises 2,4-monofurfurylidene-1,3,5,6-tetra-*O*-methyl sorbitol.

5. A filter according to any of Claims 1 to 4, in which the ratio by weight of the free-radical inhibitor to the antioxidant is from 1.5:1 to 3:1.

6. A filter according to Claim 5, in which the ratio is about 2:1.

7. A filter according to any of Claims 1 to 6 in the form of a cigarette filter.

8. A filter according to Claim 7 containing 2.5 to 30 mg of the free-radical inhibitor.

9. A filter according to Claim 8 containing about 5 to 20 mg of the free-radical inhibitor.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 95/00853

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A24D3/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A24D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR,A,1 533 175 (ISTITUTO CHEMIOTERAPICO ITALIANO) 19 July 1968 see the whole document ---	1-9
A	DATABASE WPI Week 9414 Derwent Publications Ltd., London, GB; AN 94-114240 & JP,A,06 062 824 (KYODO NYUGYO) , 8 March 1994 see abstract ---	1
A	WO,A,94 00138 (VYREX CORPORATION) 6 January 1994 see page 3, line 9 - page 4, line 19 see page 8, line 1 - page 9, line 8; example 2 --- -/--	1

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB,A,2 230 687 (PÉCSI DOHÁNYGYÁR) 31 October 1990	

Information on patent family members

International Application No
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WO-A-9400138	06-01-94	US-A-	5308874	03-05-94
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